13940

North-Central Interior Oak Savanna

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Vegetation Type

Steppe/Savanna

Map Zones

39, 40, 41

Geographic Range

Northern oak savanna occurs in a complex, shifting mosaic with oak woodlands, barrens and prairies in the upper Midwest. This type occurs in southern lower Michigan, northwestern Ohio, northern Indiana, northeastern Illinois, southern Wisconsin, and southeastern to northwestern Minnesota. This savanna/woodland/prairie type historically occurred as an ecotone between mesic hardwood forest and tallgrass prairie.

This model represents the system in map zones (MZ)s 41, 50, and 51. Within these MZs, North-Central Interior Oak Savanna occurs in sections (Cleland et al. 2007) 222J: b, h, k, I, g, e, r and 222U: e, a, and 222m and 251b.

Biophysical Site Description

Northern oak savanna occurs primarily on level to rolling topography of glacial outwash plains, coarse-textured end moraines and steep ice-contact features (Cohen 2004a, NatureServe 2004, Michigan Natural Features Inventory 2003, Cohen 2001, Albert 1995, Chapman 1984). Soils are well-drained, moderately-fertile sands, loamy sands, sandy loams, and loams with medium-acid to neutral pH (5.6 to 7.3) and low water retaining capacity (NatureServe 2004, Michigan Natural Features Inventory 2003, Chapman 1984). In general, oak savannas are most prevalent on the western side of major firebreaks such as rivers (Leitner et al. 1991, Grimm 1984, Curtis 1959). In the 1800s, oak savanna communities covered some 11-13 million ha (27-32 million ac) of the Midwest (Nuzzo 1986).

Vegetation Description

Today, northern oak savanna in the upper Midwest is limited to small, degraded remnants. As a result, little is known about the original composition and vegetative patterning of these systems (Leach and Givnish 1999). Information in this section is derived from historical accounts, early plant collections and extrapolation based on remnants within Midwestern states. The oak openings were described by Michigan settlers as park-like savanna of widely spaced mature oaks with a wide range of shrub cover above the forb and graminoid ground layer (Chapman 1984, Peters 1970, Cottam 1949, Stout 1946). The community was composed of broad-crowned, scattered oaks with a graminoid ground layer composed of species associated with both prairie and forest communities.

The canopy layer generally varied from 10-60% cover (NatureServe 2004) and was dominated by *Quercus alba* (white oak) with co-dominants including *Q. macrocarpa* (bur oak) especially in the west, and *Q. velutina* (black oak) (NatureServe 2004, Chapman 1984, Cottam 1949). White oak, black oak and bur oak with their thick bark, deep roots and resprouting abilities are the most fire-resistant of the oaks. In addition, expansive root systems that can extend down several meters and branch extensively laterally allow these oaks to withstand extreme drought stress (Faber-Langendoen and Tester 1993, Abrams 1992, Albertson and Weaver 1945). These species of oak are long-lived, often remaining as canopy dominants for 200-300yrs (Cottam 1949). Important canopy associates include, *Carya ovata* (shagbark hickory), *Quercus rubra* (red oak) and *Quercus velutina* (black oak) and, in Michigan, *Carya glabra* (pignut hickory) (NatureServe 2004). Oaks, especially black oak, are dispersed in the understory as fire-suppressed grubs which reach just over a meter tall (Anderson and Bowles 1999, Bowles and McBride 1998, Brewer and Kitler 1989, Peters 1970). Shrubs occur scattered or clumped in the understory, ranging widely in cover from 0-50% depending on fire frequency (Pruka and Faber-Langendoen 1995). The most common shrubs are fire-tolerant species such as *Corylus americana* (American hazelnut), *Ceanothus americanus* (New Jersey tea) and *Amorpha canescens* (lead-plant) (NatureServe 2004, Bader 2001, Cottam 1949, Veatch 1927). Shrubs such as *Cornus foemina* (gray dogwood), *Prunus americana* (wild plum) and *Rhus glabra* (smooth sumac) occasionally form thickets in fire-protected microsites (NatureServe2004, Bader 2001, Kline 1997).

The predominantly graminoid ground layer is composed of species associated with both prairie and forest communities. For a given oak savanna, the proportion of forbs to graminoids was likely a function of light availability and soil texture with graminoids increasing with sand and solar irradiance and forb coverage increasing with silt content and shade (Leach and Givnish 1999). Grasses, which provided the primary source of fine fuel for annual fires, reached heights of over a meter in areas of high light intensity (Anderson 1991). Common grass species included *Andropogon gerardii* (big bluestem), *Schizachyrium scoparium* (little bluestem) and *Sorghastrum nutans* (Indian grass). Prevalent forbs included *Amphicarpea bracteata* (hog peanut), *Anemone virginiana* (thimbleweed), *Asclepias purpurascens* (purple milkweed), *Asclepias tuberosa (*butterfly-weed), *Aster laevis* (smooth aster), *Coreopsis palmata* (prairie coreopsis), *Desmodium canadense* (showy tick-trefoil), *Eupatorium sessilifolium* (upland boneset), *Euphoribia corollata* (flowering spurge), *Galium boreale* (northern bedstraw), *Gentiana flavida* (white gentian*), Lathyrus venosus* (veiny pea), *Lespedeza capitata* (bush-clover), *Monarda fistulosa* (wild-bergamot), *Pycnanthemum virginianum* (mountain mint), *Rudbeckia hirta* (black-eyed Susan), *Silene stellata* (starry campion), *Solidago juncea* (early goldenrod), *Taenidia integrima* (yellow pimpernel), *Triosteum perfoliatum* (horse-gentian, feverwort), *Veronicastrum virginicum* (Culver’s root) and *Zizia aurea* (golden alexanders). (List compiled from NatureServe 2004, Bader 2001, Pruka 1995, Leach and Ross 1995, Packard 1988, Chapman 1984, Bray 1960, Curtis 1959).

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| QUAL | *Quercus alba* | White oak |
| QUVE | *Quercus velutina* | Black oak |
| QUMA2 | *Quercus macrocarpa* | Bur oak |
| ANGE | *Andropogon gerardii* | Big bluestem |
| CORYL | *Corylus* | Hazelnut |
| SCHIZ4 | *Schizachyrium* | Little bluestem |
| SONU2 | *Sorghastrum nutans* | Indiangrass |
| CEAM | *Ceanothus americanus* | New jersey tea |

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

Cottam (1949) and Curtis (1959) suggested that oak savannas originated when prairie fires spread into surrounding closed oak forest with enough intensity to create open canopy conditions (also see Anderson and Bowles 1999, Anderson and Brown 1986). Other researchers have proposed that savannas also originated following invasion of prairie by oaks during prolonged lulls in annual fire regimes (Anderson and Bowles 1999, Grimm 1984). Repeated low-intensity fires working in concert with drought and windthrow then maintained these savannas (Faber-Langendoen and Tester 1993, Curtis 1959, Stout 1946). Within dry-mesic savanna systems, such as oak openings, it is likely that annual or nearly annual fire disturbance was the primary abiotic factor influencing savanna structure and composition. Fires prevented canopy closure and the dominance of woody vegetation (Leitner et al. 1991). Presently, the prevalent catalyst of fires is lightning strike, but historically, Native Americans played an integral role in the fire regime, accidentally and/or intentionally setting fire to prairie and savanna ecosystems (Anderson and Bowles 1999, Bowles and McBride 1998, Dorney and Dorney 1989, Chapman 1984, Grimm 1984, Day 1953). Where large-scale herbivores (i.e., elk and bison) were abundant, grazing may have helped inhibit the succession of oak savanna to woodland (Ritchie et al. 1998, McClain et al. 1993).

The character of oak savannas can differ dramatically, primarily as the result of varying fire intensity and frequency, which are influenced by climatic conditions, soil texture, topography, size of physiographic and vegetative units, and landscape context (i.e., proximity to water bodies and fire-resistant and fire-conducive plant communities) (Anderson and Bowles 1999, Anderson and Bowles 1999, Anderson and Bowles 1999, Chapman et al. 1995). Historically, fire regimes were also influenced by the number and distribution of indigenous peoples (Chapman 1984). Infrequent, high-intensity fires may kill mature oaks and produce savannas covered by abundant scrubby oak sprouts. Park-like openings with widely spaced trees and an open graminoid/forb understory are maintained by frequent, low-intensity fires, which occur often enough to restrict maturation of oak seedlings and encroachment by other woody species (Peterson and Reich 2001, Chapman et al. 1995, Faber-Langendoen and Davis 1995).

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 559 | 1 |  |  |
| Moderate (Mixed) | 168 | 3 |  |  |
| Low (Surface) | 5 | 96 |  |  |
| All Fires | 5 | 100 |  |  |

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

The expected fire regimes for this type are I (frequent ground fires) and III (mixed severity). The ground fire was the more commonly occurring fire disturbance, but when dry conditions combined with dense stand conditions, a mixed-severity fire could result, with the fire crowning into the canopy where fuel ladders were present. The scale of these fires is thought to occur on tens of thousands of acres.

Adjacency or Identification Concerns

The northern oak savanna type includes several matrix communities such as mesic and dry-mesic oak openings, dry oak barrens, mixed oak and oak-hickory woodlands, and a variety of small and large patch prairie types.

This type intergrades and can be confused with more open expressions of North-Central Interior Dry-Mesic Oak Forest and Woodland (BpS 1310) and North-Central Interior Dry Oak Forest and Woodland (BpS 1311). It can be distinguished from these systems in some cases by a higher percentage of sand (though not to the excessive levels of the North-Central Oak Barrens) in ECOMAP sections 222K and 222R. This type can also intergrade with North-Central Oak Barrens (BpS 1395) as soils become increasingly sandy. In 222L it is also associated with moderate levels of silt. In ECOMPA sections 222K and 222L it is associated with the SSURGO taxonomic particle size of “fine-silty” and fine-silty over clayey.

Today, northern oak savanna in the upper Midwest is limited to small, degraded remnants. Circa 1800, oak savanna communities covered some 11-13 million ha (27-32 million ac) of the Midwest. Presently oak savanna remnants occur on just 0.02% of their circa 1800 extent (Nuzzo 1986). Following European settlement of prairies, settlement and conversion to agriculture of oak savanna rapidly followed (Kenoyer 1930). Many towns, college campuses, parks and cemeteries of the Midwest were established on former oak savanna (Packard 1988, Bronny 1989, Chapman 1984).

Alteration of historic fire regimes has shifted most oak savannas into woodlands and forest (Faber-Langendoen 1993, Curtis 1959, Cottam 1949). The decrease in Native American populations across the Midwest in the 1700-1800s likely resulted in a decrease in fire frequency. Wildfire suppression policies instituted in the 1920s in concert with road construction, expansion of towns, and increased agriculture caused a dramatic decrease in fire frequency and intensity (Abrams 1992). The reduction of fire in the landscape resulted in the succession of open oak savanna to closed-canopy forests with little advanced regeneration of oaks and a vanishing graminoid component (Chapman et al. 1995). With the absence of fire, oak savannas converted to closed canopy forest within decades (estimates range from 25-40yrs) (Stout 1946, Curtis 1959) with more mesic savannas, such as bur oak plains, deteriorating more rapidly (Packard 1993, Abrams 1992). The rapid conversion to oak forest occurred because of the prevalence in the understory of oak grubs, which are repeatedly fire-suppressed oaks with huge root masses that allowed them to achieve canopy ascension following release from annual fires (Bowles and McBride 1998, Kline 1997, Chapman 1984, Cottam 1949). Frequently these oak grubs were *Quercus velutina* (black oaks), which became canopy codominants with the advent of fire suppression.

Oak savanna remnants are often depauperate in floristic diversity as the result of fire suppression and subsequent woody encroachment, livestock grazing, and the invasion of exotic species. Sustained grazing introduced soil disturbance, prevented oak establishment, and caused decreases in native forbs and grasses with increases in weeds (native and exotic) (Jones 2000, McPherson 1997, Bray 1960).

Groundlayer vegetation of savanna remnants has been inhibited by low levels of light filtering through the dense overstories and impenetrable understories (often dominated by exotic shrubs) and by the thick litter layers that have accumulated from over a century of fire suppression (Bowles and McBride 1998).

Issues or Problems

Native Uncharacteristic Conditions

Comments

Succession Classes

**Mapping Rules**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Upper Layer Lifeform** | **Height (m)** | **Canopy Cover (%)** | | | | | | | | | |
| **0-10** | **11-20** | **21-30** | **31-40** | **41 - 50** | **51-60** | **61-70** | **71-80** | **81-90** | **91-100** |
| Herb | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Herb | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Herb | >1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 1.0-3.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | >3.0 | A | A | A | A | A | A | A | A | A | A |
| Tree | 0-5 | A | A | B | B | B | B | C | C | D | D |
| Tree | 5-10 | A | A | B | B | B | B | C | C | D | D |
| Tree | 10-25 | A | A | B | B | B | B | C | C | D | D |
| Tree | 25-50 | A | A | B | B | B | B | C | C | D | D |
| Tree | >50 | A | A | B | B | B | B | C | C | D | D |

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

**Description**

Class A 21 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| ANGE | Andropogon gerardii | Big bluestem | Low-Mid |
| SCHIZ4 | Schizachyrium | Little bluestem | Low-Mid |
| QUMA2 | Quercus macrocarpa | Bur oak | Upper |
| POTR5 | Populus tremuloides | Quaking aspen | Upper |

Description

0-50yr old class consisting of prairie grasses and forbs which dominate open grassland with scattered oak grubs and clumps of shrubs. These grubs can become trees in this class, but are fairly scattered.

Upper Layer Lifeform is not the dominant lifeform. Herbs, up to 1m tall, ranging in cover from 0-100%, tending towards 100%.

*Maximum Tree Size Class*  
Medium 9-21"DBH

Class B 63 Late Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| QUAL | Quercus alba | White oak | Upper |
| QUMA2 | Quercus macrocarpa | Bur oak | Upper |
| ANGE | Andropogon gerardii | Big bluestem | Lower |
| CORYL | Corylus | Hazelnut | Middle |

Description

This is a system of widely-scattered, large-diameter oaks and shrub clumps within a matrix of prairie grasses and forbs (21-60% canopy closure).

*Maximum Tree Size Class*  
Large 21-33"DBH

Class C 14 Late Development 2 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| QUAL | Quercus alba | White oak | Upper |
| QUMA2 | Quercus macrocarpa | Bur oak | Upper |
| QUVE | Quercus velutina | Black oak | Lower |

Description

Open canopy (60-80% canopy closure) oak-dominated woodland with high stem density. These oak groves occupy areas of the landscape that frequently escape fire due to topographic position.

*Maximum Tree Size Class*  
Very Large >33"DBH

Class D 2 Late Development 3 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| QUAL | Quercus alba | White oak | Upper |
| QUMA2 | Quercus macrocarpa | Bur oak | Upper |
| CAOV2 | Carya ovata | Shagbark hickory | Upper |
| PRSE2 | Prunus serotina | Black cherry | Low-Mid |

Description

This is a closed-canopy (81-100%) oak-dominated forest with scattered hickories. These oak groves occupy areas of the landscape that frequently escape fire due to topographic position.

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*Maximum Tree Size Class*  
Large 21-33"DBH

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Late1:OPN | 50 |
| Late1:OPN | 51 | Late1:OPN | 999 |
| Late2:OPN | 51 | Late2:OPN | 999 |
| Late3:CLS | 51 | Late3:CLS | 999 |

Probabilistic Transitions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Disturbance Type** | **Disturbance occurs In** | **Moves vegetation to** | **Disturbance Probability** | **Return Interval (yrs)** | **Reset Age to New Class Start Age After Disturbance?** | **Years Since Last Disturbance** |
| Alternative Succession | Early1:ALL | Late3:CLS | 0.001 | 1000 | Yes | 0 |
| Alternative Succession | Early1:ALL | Late2:OPN | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Early1:ALL | Early1:ALL | 0.001 | 1000 | No | 0 |
| Native Grazing | Early1:ALL | Early1:ALL | 0.001 | 1000 | No | 0 |
| Replacement Fire | Early1:ALL | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Mixed Fire | Early1:ALL | Early1:ALL | 0.01 | 100 | No | 0 |
| Surface Fire | Early1:ALL | Early1:ALL | 0.2 | 5 | No | 0 |
| Alternative Succession | Late1:OPN | Late2:OPN | 1 | 1 | Yes | 25 |
| Wind or Weather or Stress | Late1:OPN | Late1:OPN | 0.001 | 1000 | No | 0 |
| Native Grazing | Late1:OPN | Late1:OPN | 0.001 | 1000 | No | 0 |
| Replacement Fire | Late1:OPN | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Mixed Fire | Late1:OPN | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Surface Fire | Late1:OPN | Late1:OPN | 0.2 | 5 | No | 0 |
| Alternative Succession | Late2:OPN | Late3:CLS | 1 | 1 | Yes | 30 |
| Native Grazing | Late2:OPN | Late2:OPN | 0.001 | 1000 | No | 0 |
| Wind or Weather or Stress | Late2:OPN | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Replacement Fire | Late2:OPN | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Mixed Fire | Late2:OPN | Late1:OPN | 0.002 | 500 | Yes | 0 |
| Surface Fire | Late2:OPN | Late2:OPN | 0.2 | 5 | No | 0 |
| Native Grazing | Late3:CLS | Late3:CLS | 0.001 | 1000 | No | 0 |
| Wind or Weather or Stress | Late3:CLS | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Replacement Fire | Late3:CLS | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Mixed Fire | Late3:CLS | Late1:OPN | 0.025 | 40 | Yes | 0 |
| Surface Fire | Late3:CLS | Late3:CLS | 0.1 | 10 | No | 0 |

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